



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

Langley

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REPLY TO
ATTN OF: GP

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,864,060

Government or
Corporate Employee : U.S. Government

Supplementary Corporate
Source (if applicable) :

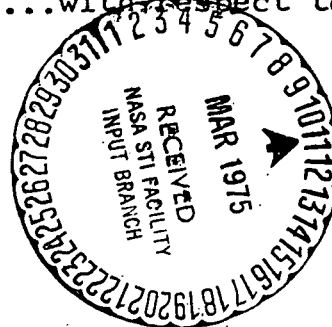
NASA Patent Case No. : LAR-11,071-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

YES ☐ NO ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "...with respect to an invention of ..."

Bonnie L. Woerner
Enclosure



(NASA-Case-LAR-11071-1) AUTOMATIC LIQUID
INVENTORY COLLECTING AND DISPENSING UNIT
Patent (NASA) 6 p CSCI 14B
00/35 Unclas 11849
N75-19611

[54] **AUTOMATIC LIQUID INVENTORY
COLLECTING AND DISPENSING UNIT**

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[73] Assignee: The United States of America as
represented by the Administrator of
the National Aeronautics and Space
Administration, Washington, D.C.

[22] Filed: Feb. 21, 1973

[21] Appl. No.: 334,349

[52] U.S. Cl. 417/36, 73/221, 417/138,
417/395

[51] Int. Cl. F04b 49/00, F04b 43/04, F04f 1/06

[58] Field of Search 73/219, 221, 250; 417/122,
417/123, 125, 132, 129, 138, 395; 413/36, 37

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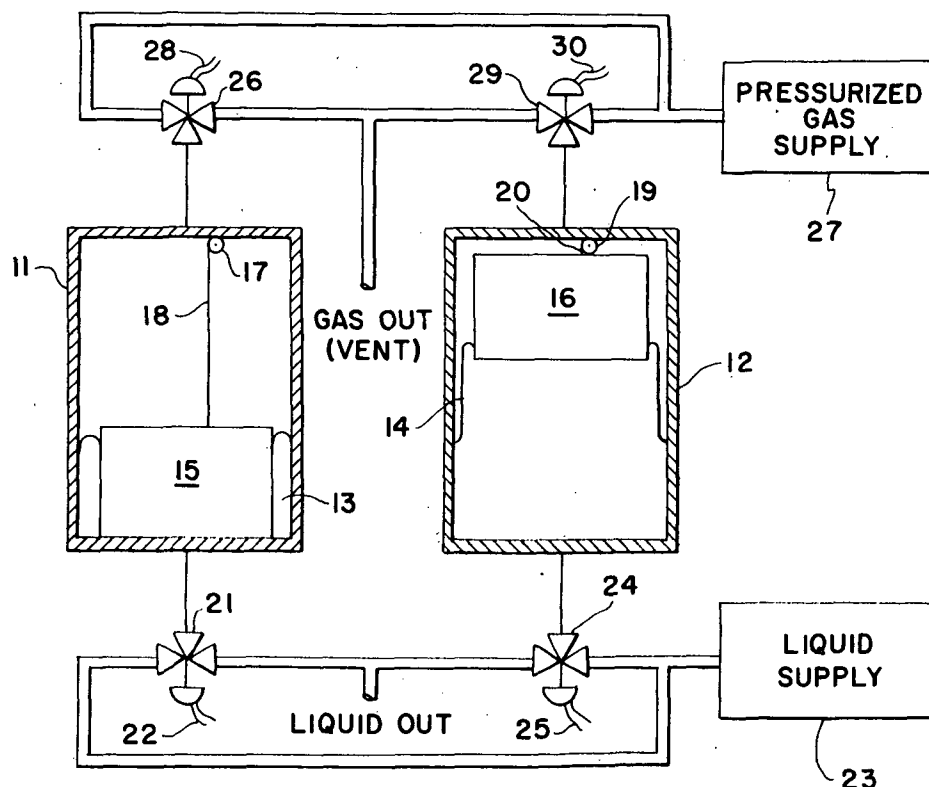
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[57]

ABSTRACT

This invention provides means for automatically collecting waste liquids and for simultaneously feeding these liquids into water recovery processes. The invention includes first and second tanks with first and second two-way solenoid valves associated with each of the tanks. The first solenoid valve is connected to the liquid source and its associated tank so as to allow liquid to flow into the tank when the valve is in its normal position and to allow the liquid to flow out of the tank when the valve is in its actuated position. The second valve is connected to its associated tank and a gas supply so as to allow gas inside the tank to flow out when the valve is in its normal position and to allow gas to flow from the gas supply into the tank when the valve is in its actuated position. Control circuit means are included for actuating the two valves associated with the first tank and not actuating the valves associated with the second tank when both said first tank is filled and said second tank is emptied and for not actuating the two valves associated with said first tank and for actuating the two valves associated with said second tank when both said first tank is emptied and said second tank is filled, whereby both tanks are alternately filled and emptied. The invention also includes means for indicating which tank is being filled and which tank is being emptied, means for indicating the liquid level in each of the tanks, means for counting the number of times the first and second tanks are filled and means for making the invention operable in a near-zero gravity environment.

2 Claims, 2 Drawing Figures



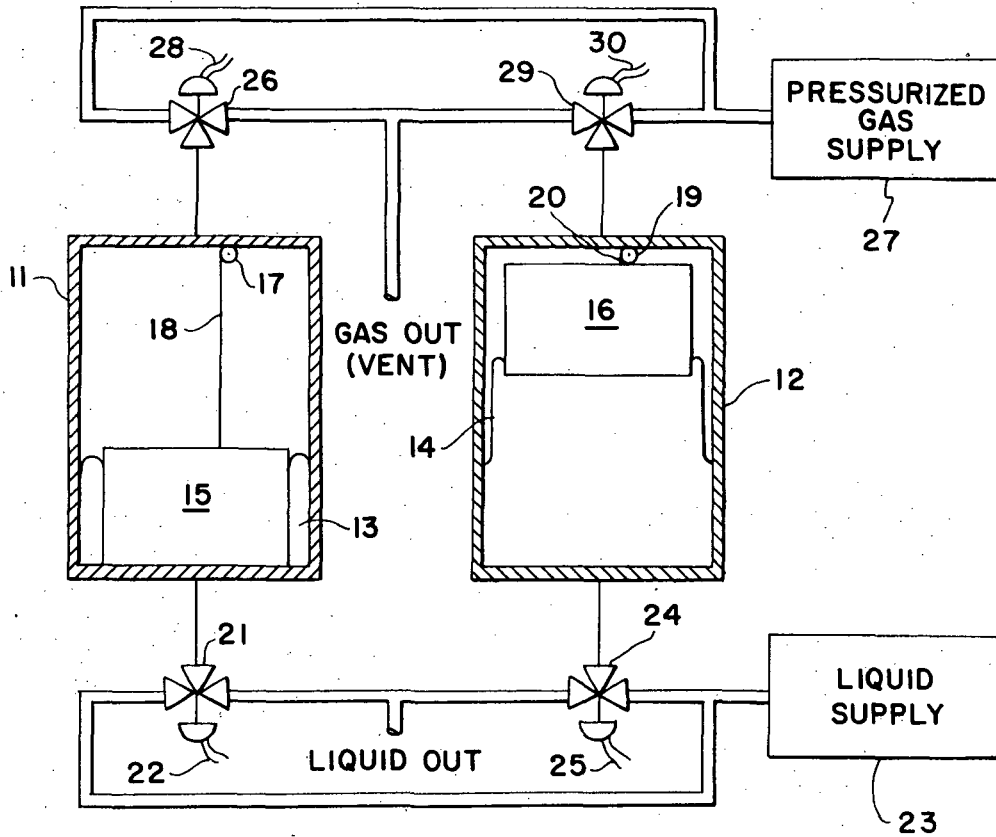
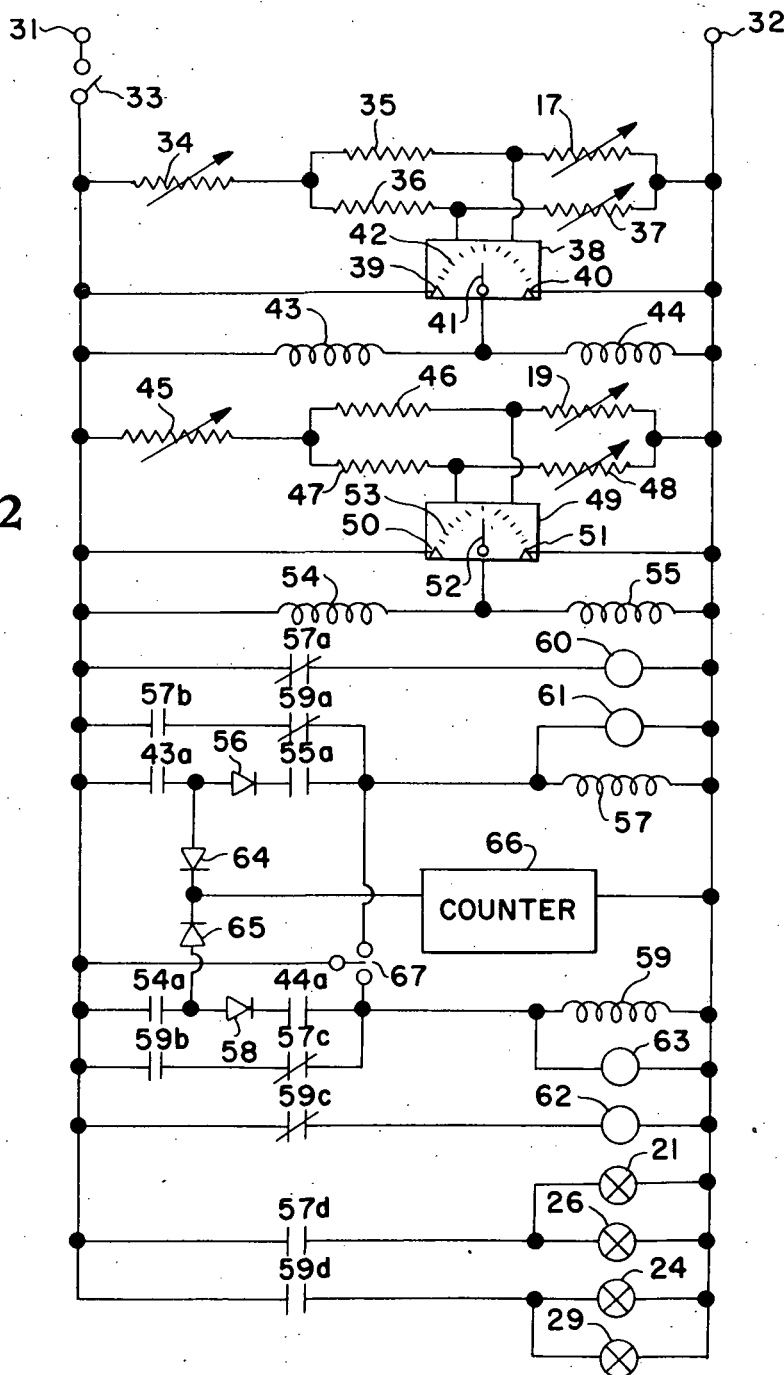


FIG. 1

FIG. 2



AUTOMATIC LIQUID INVENTORY COLLECTING AND DISPENSING UNIT

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the National Aeronautics and Space Administration and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The general purpose of this invention is to provide means for automatically collecting waste liquids while at the same time feeding these liquids into water recovery processes. In addition, the invention can be used to store and concurrently dispense the processed water. The collection and dispensing function has been performed manually in the past by utilizing two or more tanks. The water inventory techniques used in the past are the graduated water-site gages, tank pressure volume calibration, and weighing techniques. The disadvantages of these techniques are that manual operation of collection and dispensing devices require continuous surveillance by the operators. This is very time-consuming and does not allow the operators to perform other duties. Water inventory techniques such as site gages and weighing fixtures will not operate in zero gravity. Tank pressure water volume techniques require additional pumping to fill the tanks. The back pressure on the gas side of the liquid gas interface has to be equalized prior to water transfer into the unit.

SUMMARY OF THE INVENTION

Basically, the invention consists of two bladdered tanks, separate control and readout circuits for each tank, appropriate valves and plumbing to simultaneously collect and dispense liquid as well as continuously maintain an inventory of the liquid in the tanks. Each of the tanks has first and second two-way solenoid valves associated with it with the first connected to the liquid source and its tank so as to allow the liquid to flow into the tank when the valve is in its normal position and to allow the liquid to flow out of the tank when the valve is in its actuated position and with the second valve connected to the tank and gas supply so as to allow gas inside the tank to flow out when the valve is in its normal position and to allow gas to flow from the gas supply into the tank when the valve is in its actuated position. The four solenoid valves are connected to a control circuit means which actuates the two valves associated with the first tank and which does not actuate the two valves associated with the second tank when both said first tank is filled and said second tank is emptied, and for not actuating the two valves associated with the first tank and for actuating the two valves associated with the second tank when both said first tank is emptied and said second tank is filled whereby said first and second tanks are alternately filled and emptied. The invention also includes means for indicating at any given time which tank is being filled and which tank is being emptied, means for counting the number of times the first and second tanks are filled, means for indicating at any given time the liquid levels in the two tanks, and means for making the invention operable in a zero gravity environment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic drawing of the two tanks and the plumbing associated therewith in the embodiment of the invention selected for illustration in the drawings; and

FIG. 2 is a schematic drawing of the electrical circuitry used in the embodiment of the invention selected for illustration in the drawings.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to the embodiment of the invention selected for illustration in the drawings, the numbers 11 and 12 in FIG. 1 designate tanks. Located inside tanks 11 and 12 are rolled bladders 13 and 14 for holding the liquid. Bladder 13 is shown in its emptied state and bladder 14 is shown in its filled state. These bladders are made from any suitable flexible material such as rubber. Also located inside tanks 11 and 12 are pistons 15 and 16 for applying pressures against rolled bladders 13 and 14, respectively. Rotary potentiometers 17 and 19 are connected to the two pistons 15 and 16, respectively, by negator springs 18 and 20, such that as pistons 15 and 16 move up and down the outputs of potentiometers 17 and 19 vary. A two-way solenoid valve 21 is coupled to rolled bladder 13 and a liquid supply 23 such that when no voltage is applied to leads 22, liquid will flow from the liquid supply 23 through valve 21 into bladder 13 and when a voltage is applied to leads 22, the liquid inside bladder 13 will flow through valve 21 to the right side of the valve and out of the system. A two-way solenoid valve 24 is coupled to rolled bladder 14 and to liquid supply 23 such that when no voltage is applied to leads 25 the liquid from liquid supply 23 will flow through the valve into bladder 14 and when a voltage is applied to leads 25 the liquid inside bladder 14 will flow through the left side of valve 24 out of the system.

A two-way solenoid valve 26 is coupled to tank 11 and to a pressurized gas supply 27 such that when a voltage is applied to leads 28, gas from the gas supply 27 will flow through valve 26 into tank 11 and when no voltage is applied to leads 28, the gas inside tank 11 will be vented out of the right side of valve 26. A two-way solenoid valve 29 is coupled to tank 12 and to pressurized gas supply 27 such that when a voltage is applied to leads 30, gas will flow from gas supply 27 into tank 12 and when a voltage is not applied to leads 30 the gas in tank 12 will be vented out of the left side of valve 29. Inasmuch as gas supply 27 is under pressure when the gas flows into either of the two tanks it will force the liquid out of the tank. Hence, the invention is operable in a zero gravity environment since gravity is not necessary for its operation.

In the control circuit shown in FIG. 2, a suitable voltage source such as 28 volts d.c. is applied across terminals 31 and 32. A switch 33 is in the line connected to terminal 31 for the purpose of connecting and disconnecting the voltage source to the control circuit. With switch 33 closed, a variable resistor 34 is connected in series with a bridge circuit consisting of resistors 35 and 36, variable resistor 37 and potentiometer 17, across the voltage source. The junction of resistor 35 and potentiometer 17 and the junction of resistor 36 and variable resistor 37 are connected to a voltmeter 38. A low set point 39 of meter 38 is connected to one side of the potential and a high set point 40 of voltmeter 38 is con-

connected to the other side of the potential. The meter 38 has a needle 41 and a scale 42 on its face. Needle 41 is connected to the junction of a relay coil 43 and a relay coil 44 that are connected in series across the voltage source. The scale 42 is precalibrated to indicate the level of liquid in tank 11. That is, as the level of liquid in tank 11 changes the resistance of potentiometer 17 changes which in turn changes the position of needle 41 relative to scale 42. Hence, scale 42 can relate directly to the level of liquid in tank 11. When tank 11 is empty, needle 41 contacts low set point 39 thereby connecting relay coil 44 directly across the voltage source causing its contacts to be actuated. When tank 11 is full, needle 41 contacts the high set point 40 thereby connecting relay coil 43 across the voltage source.

A variable resistor 45 and a bridge circuit consisting of resistors 46 and 47, variable resistor 48 and potentiometer 19 are connected in series across the voltage source. The junction of resistor 46 and potentiometer 19 and the junction of the resistor 47 and variable resistor 48 are connected to a meter 49. A low set point 50 of meter 49 is connected to one side of the voltage source and a high set point 51 of meter 49 is connected to the other side of the voltage source. The needle 52 of meter 49 is connected to the junction of relay coils 54 and 55 which are connected in series across the voltage source. Meter 49 also has scale 53 on its face which is precalibrated to represent the level of liquid in tank 12. When tank 12 is empty, needle 52 contacts low set point 50 thereby connecting relay coil 55 directly across the voltage source causing its contacts to be actuated; and when tank 12 is full, needle 52 contacts high set point 51 thereby connecting relay coil 54 across the voltage source.

A set of normally open relay contacts 43a, a diode 56, a set of normally open relay contacts 55a, and a relay coil 57 are connected in series across the voltage source. All relay contacts are actuated by the relay coil designated by the same number. A set of normally open relay contacts 54a, a diode 58, a set of normally open relay contacts 44a and a relay coil 59 are connected in series across the voltage source. A set of normally closed relay contacts 57a and a fill light indicator 60 are connected in series across the voltage source. A set of normally open relay contacts 57b and a set of normally closed relay contacts 59a are connected in series between terminal 31 and the junction of relay contacts 55a and relay coil 57. A dump light indicator 61 is connected across relay coil 57. A set of normally open relay contacts 59b and a set of normally closed relay contacts 57c are connected in series between terminal 31 and the junction of relay contacts 44a and relay coil 59. A dump light indicator 61 is connected across relay coil 59. A set of normally closed relay contacts 59c and a fill light indicator 62 are connected in series across the voltage source.

Valve 21 is connected in series with normally open relay contacts 57d across the voltage source, and valve 24 is connected in series with the normally open relay contacts 59b across the voltage source. Valve 26 is connected in parallel with valve 21 and valve 29 is connected in parallel with valve 24. Diodes 64 and 65 are connected in series between the junction of contacts 43a and diode 56 and the junction of contacts 54a and diode 58. A counter 66 is connected between the junction of diode 64 and 65 and terminal 32. A switch 67

is connected as shown between terminal 31, the junction of contacts 55a and relay coil 57 and the junction of contacts 44a and relay coil 59. Counter 66 counts the number of times that relay contacts 43a and 54a close.

In describing the operation of this invention, it will be assumed that initially both tanks 11 and 12 are full. Hence, needle 41 is in contact with high set point 40 energizing relay coil 43 and needle 52 is in contact with high set point 51 energizing relay coil 54. Consequently, relay contacts 43a and 54a are closed and a count of two appears on counter 66. Then to start the sequence of operations, switch 67 is actuated and it will be assumed that it is actuated such that coil 59 is energized. Then relay contacts 59b close, completing a circuit through relay contacts 59b, relay contacts 57c and relay coil 59 to keep relay coil 59 energized. Dump light 63 is also energized indicating that tank 12 is being dumped. While relay coil is energized, relay contacts 59a and 59c are open thereby assuring that relay coil 57 and fill light indicator 62 are not energized. Also relay contacts 59d are closed energizing both valve 24 and valve 29. This results in the liquid in tank 12 being dumped. As the liquid is being dumped, that is, as the gas flows into tank 12 forcing the piston 16 against bladder 14, piston 16 is moved away from its top position thereby decreasing the output of potentiometer 19. Against bladder 14, piston 16 is moved away from its top. This decrease can be noted by the movement of the needle 52.

When tank 12 is emptied, needle 52 contacts low set point 50 energizing relay coil 55. This will close relay contact 55a, energizing relay coil 57 since contacts 43a are closed. This closes relay contacts 57b completing the holding circuit for relay coil 57. Light 61 is energized indicating that the liquid in tank 11 is being dumped and relay contacts 57a are opened turning off the fill light indicator 60. Relay contacts 57c are opened de-energizing relay coil 59 and relay contacts 57b are closed energizing valves 21 and 26. Since relay coil 59 is de-energized relay contacts 59 assume their normal position thereby de-energizing valves 24 and 29. Since valves 24 and 29 are deenergized, the liquid from liquid supply 23 flows through valve 21 into the bladder 13 of tank 11 and the gas inside tank 11 is vented out through valve 26. When tank 11 is filled, needle 52 makes contact with high set point 51, energizing coil 54 which closes relay contacts 54a thereby producing another count on counter 66. Since valves 21 and 26 are energized, the gas from gas supply 57 flows through valve 26 into tank 11 forcing the liquid in bladder 13 out through valve 21. When tank 11 is emptied needle 41 makes contact with low set point 39 completing an electrical circuit through relay coil 44, coil 59 which completes a cycle of this invention. Diodes 56 and 58 are blocking diodes to prevent false counts when relays 44 and 55 are energized.

The advantages of this invention are that it is automated to allow the simultaneous collection and dispensing of liquids as well as maintaining an inventory of liquid in the tanks. These features eliminate the need for manual operation which reduces the manpower requirement to operate the unit.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An automatic liquid inventory collecting and dispensing unit comprising:

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first and second tanks;

first and second two-way solenoid valves associated with each of said tanks with the first coupled to a liquid source and its associated tank for allowing the liquid to flow into the tank when the first valve is in its normal position and for allowing the liquid to flow out of the tank when the first valve is in its actuated position and with the second valve connected to its associated tank and a pressurized gas supply for allowing gas inside the tank to flow out when the valve is in its normal position and for allowing gas to flow from the gas supply into the tank when the valve is in its actuated position;

control circuit means for actuating the two valves associated with said first tank and not actuating the two valves associated with the said second tank when both said first tank is filled with liquid and said second tank is emptied for not actuating the two valves associated with said first tank and for

6

actuating the two valves associated with said second tank when both said first tank is emptied and said second tank is filled with liquid whereby said first and second tanks are alternately filled and emptied;

said control circuit means including a piston inside each of said first and second tanks to form a compartment inside each tank for the liquid and a compartment inside the tank for the gas and including a potentiometer associated with each of said tanks and means attached to each said potentiometer and the associated piston for varying the potentiometer in accordance with the movement of said piston.

2. A liquid and dispensing unit according to claim 1 including means for measuring the output of said potentiometer to give an indication of the liquid level in the tank.

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